AFCRL-71-0588

AD 740847

INFRARED ROCKET ASTRONOMY

MARTIN O. HARWIT, JAMES R. HOUCK,
JUDITH L. PIPHER, and BARUCH T. SOIFER

Center for Radiophysics and Space Research, Space Science Building
Cornell University, Ithaca, N.Y. 14850

Contract No. F19628-70-C-0128
Project No. 8692

Annual Report No. 2

15 November 1971

Contract Monitor: Stephan D. Price
Optical Physics Laboratory

Approved for public release; distribution unlimited.

The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the Advanced Research Projects Agency or the U. S. Government.

Sponsored by
Advanced Research Projects Agency
ARPA Order No. 1366

Monitored by
AIR FORCE CAMBRIDGE RESEARCH LABORATORIES
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
BEDFORD, MASSACHUSETTS 01730

13

ACCESSION for		
CFSTI	WHITE SECTION ☒	
DDC	BUFF SECTION ☐	
UNANNOUNCED	☐	
JUSTIFICATION		
BY		
DISTRIBUTION/AVAILABILITY CODES		
DIST.	AVAIL. and/or SPECIAL	
A		

Program Code No.	OE50
Effective Date of Contract	6 November 1969
Contract Expiration Date	31 December 1971
Principal Investigator and Phone No.	Dr. Martin O. Harwit/607-256-4805
Project Scientist or Engineer and Phone No.	Stephan D. Price/617-861-2501

Qualified requestors may obtain additional copies from the Defense Documentation Center. All others should apply to the National Technical Information Service.

10

Unclassified
Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) Cornell University Center for Radiophysics and Space Research Space Science Building Ithaca, New York 14850	2a. REPORT SECURITY CLASSIFICATION Unclassified 2b. GROUP

3. REPORT TITLE

INFRARED ROCKET ASTRONOMY

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)
Scientific Interim.

5. AUTHOR(S) (First name, middle initial, last name)
Martin O. Harwit, Judith L. Pipher
James R. Houck, Baruch T. Soifer

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
15 November 1971	11	2

8a. CONTRACT OR GRANT NO. ARPA Order No. F19628-70-0128 1366 b. PROJECT NO. 8692 N/A N/A c. 62301D d. N/A	9a. ORIGINATOR'S REPORT NUMBER(S) Annual Report No. 2 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report) AFCRL -71-0588

10. DISTRIBUTION STATEMENT

A - Approved for public release; distribution unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
This research was supported by the Advanced Research Projects Agency.	Air Force Cambridge Research Laboratories (OP) L.G. Hanscom Field Bedford, Massachusetts 01730

13. ABSTRACT

This report describes the work completed between 10 May 1971 and 15 November 1971, and is divided into eight sections:

A) Performance of telescope system,
B) Integration and vibration testing,
C) Rocket flight NP 3.39 -- 16 July 1971,
D) Performance of the reassembled telescope system,
E) Results of 16 July 1971 flight,
F) Ground Based Effort,
G) Personnel,
H) Publications.

?

DD FORM 1 NOV 65 1473

Unclassified
Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Infra-red.						
Detectors.						
Cryogenic Telescope.						
Sounding Rocket.						

AFCRL - 71-0588

INFRARED ROCKET ASTRONOMY

Martin O. Harwit, James R. Houck,
Judith L. Pipher, and Baruch T. Soifer

Center for Radiophysics and Space Research, Space Science Building
Cornell University, Ithaca, N.Y. 14850

Contract No. F19628-70-C-0128

Project No. 8692

Annual Report No. 2

15 November 1971

Contract Monitor: Stephan D. Price
Optical Physics Laboratory

Sponsored by

Advanced Research Projects Agency

ARPA Order No. 1366

Monitored by

AIR FORCE CAMBRIDGE RESEARCH LABORATORIES
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
BEDFORD, MASSACHUSETTS 01730

ABSTRACT

This report describes the work completed between 10 May 1971 and 15 November 1971, and is divided into eight sections:

A) Performance of telescope system,

B) Integration and vibration testing,

C) Rocket flight KP 3.39 -- 16 July 1971,

D) Performance of the reassembled telescope system,

E) Results of 16 July 1971 flight,

F) Ground based effort,

G) Personnel,

H) Publications.

A) Performance of the Telescope System

The new optical system was calibrated using a blackbody radiation source.[1] The following results were obtained:

Channel Number	Wavelength Range (μ)	NEP (System)	NEFD
1	5-6	1.8×10^{-13} Watts $Hz^{-1/2}$	10^{-15} $W/cm^2 Hz^{1/2}$
2	12-14	8×10^{-15} "	4×10^{-17} "
3	16-23	3×10^{-14} "	2×10^{-16} "
4	70-130	$[illegible].7\times10^{-13}$ "	0.8×10^{-15} "
5	200-300	1.5×10^{-11} "	0.8×10^{-13} "
6	300-1300	2×10^{-12} "	1×10^{-14} "

The sensitivity figures listed above are for the entire telescope system. As such they do not include corrections for filter or chopper losses. These figures are not as good as the corresponding figures for the A0400.4-3 payload. Since the new optical system had 3 additional mirrors, and new light pipes, the fact that the new sensitivities were within a factor of 10 of the previous results was considered a successful change.

Unfortunately the mirrors delivered were unsatisfactory in surface quality, so that the off-axis rejection was not improved substantially over that previously reported.[2] Even with the poor quality primary mirror the off axis rejection was comparable to that observed with the A0400.4-3 system at small zenith angles, and better at the large zenith angles required for the KP3.39 flight.

---

[1] J.R. Houck and M.O. Harwit, Science 1271, <u>164</u> (1969).

[2] M. Harwit, J.R. Houck, J.L. Pipher, and B.T. Soifer, Semiannual Report No. 2. Report No. AFCRL-71-0328.

B) Integration and Vibration Testing

The payload was shipped to Kitt Peak National Observatory in Tucson, Arizona, for integration and vibration testing during the week of 9 June 1971. The integration tests were performed on 9 June 1971 and vibration tests on 10 June 1971. These tests were followed by a "turn on" to check the functioning of the system after vibration. No problems were encountered during the vibration or turn on tests. Only a few minor problems were encountered during the integration tests. The payload and support equipment were shipped directly from Kitt Peak to White Sands for the flight.

C) <u>Rocket Flight KP 3.39 -- 16 July 1971</u>

The payload was prepared for flight at WSMR between 13 June 1971 and 21 June 1971. A pre-horizontal check was made on 18 June 1971 and a horizontal check on 21 June 1971. Unfortunately, because of a week postponement of an Aerobee 350 [illegible], and a full schedule for use of the Aerobee 350 tower the week following our scheduled launch, the rocket was unable to go into the launch tower in June. The flight was rescheduled for 16 July 1971 and preparations for this launch were made from 12 July 1971 to 16 July 1971. An unofficial horizontal check was made on 14 July 1971 (the June horizontal was official) and the vertical check on 15 July 1971.

The rocket, an Aerobee 170, was launched at 21:53 MST on 16 July 1971. All parts of the payload functioned as expected. There were no problems with either the cryogenic or vacuum systems. A problem with the ACS system was discovered upon reduction of the aspect pictures, taken by a Nikon camera, flown with the payload. The analysis of the aspect pictures revealed that the point of tip eject was about 10° off the planned point of tip eject. The actual scan pattern was correct throughout the flight in terms of lengths of scans, and angles between scans, however the entire pattern was affected by the initial error. Fortuitously, the one point of the original scan pattern that was actually scanned was the galactic center. There has been no hypothesis put forth as to the cause of the ACS error. The ACS system was tested following the flight, and performed nominally.

The payload was recovered in excellent condition on 17 July 1971.

D) Performance of the Reassembled Telescope System

The telescope system was reassembled following the 17 July 1971 flight, and recalibrated. The results were in excellent agreement with the preflight calibrations listed on page 3. Inspection of the system revealed virtually no damage to the system from the flight.

E) Results of 16 July 1971 Flight

The results and implications for the 4 shortest wavelength detectors are presented in the First Data Report, which contains the text of two papers "Rocket Infrared 4-Color Photometry of the Galaxy's Central Regions," by J.R. Houck, B.T. Soifer, J.L. Pipher, and M. Harwit, and "Why Many Infrared Astronomical Sources Emit at 100μm" by M. Harwit, B.T. Soifer, J.R. Houck, and J.L. Pipher. The first of these papers has been published in the Astrophysical Journal (169, L31). The second paper has been submitted for publication in the journal Nature.

The two long wavelength detectors did not function properly during the flight and this problem is being studied, in an attempt to determine the cause. The preliminary hypothesis is that the malfunction is a result of radio frequency interference, which did not reveal itself during any of the preflight tests. We base this hypothesis on the fact that the telemetry frequency was 2 GHz for this flight, whereas for AO 400.4-3, in which these detectors worked well, the telemetry frequency was 234 MHz. Also these two detectors are the most susceptible to this kind of effect.

F) Ground Based Effort

The ground-based photometer was taken to Mauna Kea Observatory at the beginning of October. A total of 8 days of observing time on the 24" telescope were spent, of which about 70% of the time was useful for observing. Observations were made at both 10μ and 20μ. Much time was spent searching for the sources observed in the KP3.39 rocket flight, as well as sources from previous Cornell rocket flights. The data is currently being reduced, however no positive indication has been found for these sources. This would indicate that these are non point-like sources, since with the measured sensitivity of the photometer, sources of the observed strength would have been seen with very high signal to noise (≥ 10) in one second. (This is true, of course, only if our aspect positions are correct, however we have fairly good agreement with known objects.)

The equipment performed up to expectations on the telescope. The previous problems of microphonics seem to have been eliminated with the newly designed chopper and a new type of detector mount.

G) Personnel

Name	Function or Area of Responsibility	Support
M.O. Harwit	Project Scientist	Part Time
J.R. Houck	Project Scientist	Part Time
J.L. Pipher	Long Wavelength Detectors	Part Time
B.T. Soifer	Short Wavelength Detectors	Part Time
J. Stasavage	Technician	Part Time

H) Publications

J.R. Houck, B.T. Soifer, J.L. Pipher, and M. Harwit, "Rocket Infrared 4-Color Photometry of the Galaxy's Central Regions" Ap.J. 169, L31 (1971).

M. Harwit, B.T. Soifer, J.R. Houck, J.L. Pipher, "Why Many Infrared Astronomical Sources Emit at 100μm" submitted to Nature.

B.T. Soifer, J.R. Houck and Martin Harwit "Rocket Infrared Observations of the Interplanetary Medium" Ap.J. 168, L73 (1971).